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CLIMATE & METEOROLOGY SECTION

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REDUCTION OF 1985 WATER YEAR PRECIPITATION DATA FOR CHICAGO

by John L. Vogel

Prepared for the
Illinois Department of Transportation
Division of Water Resources

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INTRODUCTION

The volume of water diverted from Lake Michigan by Illinois is monitored to ensure that Illinois does not exceed the limit of 3,200 cfs imposed by the U. S. Supreme Court Order of 1967 (Pavia, 1979). An important component of the accounting procedure is the accurate representation of the precipitation that falls over Chicago and part of Northeast Illinois. The precipitation patterns over the Chicago area during the 1983 and 1984 Water Years were unusual compared to past climatic studies (Changnon, 1961; Changnon, 1968; Huff and Changnon, 1973; Vogel, 1988), and the annual precipitation totals at a number of the stations for the two Water Years were also unusually low when compared to the Chicago area and Northeast Illinois. A Water Year runs from 1 October to 30 September. It was determined that these unusual patterns were caused by 1) inadequate raingage exposure, and 2) different observing, data reduction, and quality control practices by the groups taking the data (Vogel, 1988).

The 1985 Water Year again exhibited a precipitation pattern similar to those of the 1983 and 1984 Water Years. Figure 1 shows the uncorrected precipitation pattern for the 1985 Water Year. This precipitation pattern, similar to those of the 1983 and 1984 Water Years, shows low precipitation amounts in the northern and southern parts of the Chicago region, and a general maximum near the center of the Chicago area. Previous analysis of the precipitation pattern in the Chicago area (Changnon, 1961; Changnon, 1968; Huff and Changnon, 1973; and Vogel, 1988) indicates that such a

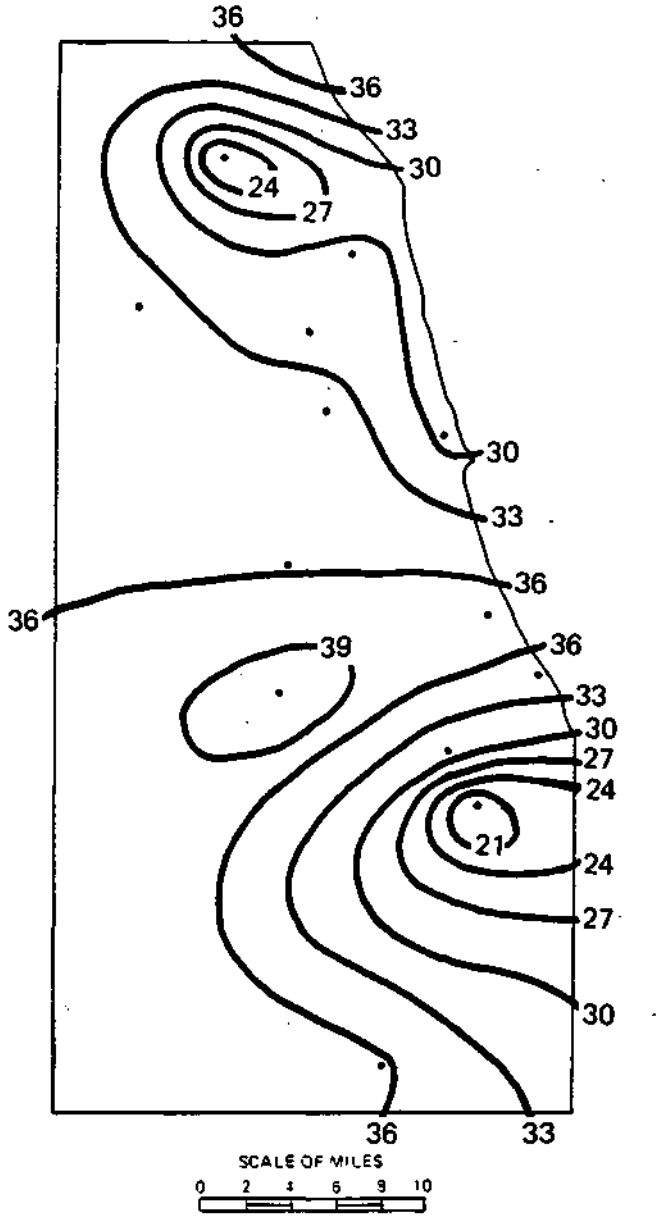

Figure 1. Water Year 1985 precipitation pattern in inches from original records (dots indicate raingages used in analysis)

pattern is not typical for the region. Vogel (1988) further established that the spatial distribution of annual precipitation, similar to Figure 1, began to occur in 1967, and that the annual amount of precipitation that fell in certain raingages in the Chicago area shifted at this time.

Storm precipitation amounts are important to the accounting procedure developed by the Illinois Department of Transportation. As a result, a procedure was devised to estimate the precipitation for individual storms that occurred during the 1984 Water Year (Vogel, 1988). This same procedure, described later, estimated revised precipitation storm amounts for the 1985 Water Year (1 October 1984 through 30 September 1985). A magnetic tape with this information was forwarded to the Northeast Illinois Planning Commission in October 1987. The cumulative corrections from these storms are presented, and the modified spatial precipitation patterns for the 1985 Water Year are provided.

RAINGAGES AND DATA

Thirteen raingages in the Chicago area (Table 1) are used by the Illinois Department of Transportation to evaluate the precipitation for the Lake Michigan diversion accounting procedure. All of these stations, except Park Forest, are recording raingages providing hourly precipitation amounts. The raingages used for the accounting procedure are managed by three different groups: 1) the National Weather Service (NWS); 2) the City of Chicago; and 3) the Metropolitan Sanitary District of Greater Chicago (MSD). Three different recording raingage types are used and a standard 8-inch non-recording raingage is used at Park Forest by the NWS. The NWS uses weighing-bucket raingages at O'Hare and the University of Chicago, and a Fischer-Porter raingage at Midway 3 SW. The remaining gages are tipping-

Table 1. Raingage Locations

Raingages Used for Accounting Procedure

Calumet Treatment Plant (M)	Chicago O'Hare Airport (N)
Glenview (M)	Mayfair Pump Station (C)
Midway 3 SW (N)	Park Forest (N)
Roseland Pump Station (C)	Sanitary District Office (M)
Skokie Northside Treatment Works (M)	South Water Filtration Plant (C)
Springfield Pump Station (C)	University of Chicago (N)
West Southwest Treatment Plant (M)	

Additional Raingages Used for Analysis

Antioch (N)	Aurora (N)
Barrington (N)	Channahon/Dresden Island (N)
Chicago Botanic Gardens (N)	Elgin (N)
Jardine Water Treatment Plant (C)	Joliet Brandon Road Dam (N)
Marengo (N)	McHenry (N)
Peotone (N)	Waukegon (N)
Wheaton (N)	

C = City of Chicago
M = Metropolitan Sanitary District of Greater Chicago
N = National Weather Service

bucket raingages maintained by the City of Chicago or the MSD. The spatial distribution of the raingages used for the accounting procedure is given in Figure 2.

Hourly precipitation data from NWS raingages for the 1985 Water Year were obtained from Hourly Precipitation Data. Illinois published by the National Climatic Data Center (NCDC). Daily precipitation data for Park Forest were acquired from Climatological Data. Illinois published by the NCDC. Hourly precipitation data for Mayfair Pump Station, Roseland, South Filter Plant, and Springfield Pump Station were obtained from the City of Chicago. For the remaining tipping-bucket raingages copies of the original recording charts were provided by the MSD. These charts were reduced, and uncorrected hourly precipitation amounts for the 1985 Water Year were produced. The only station in the Chicago area with precipitation records

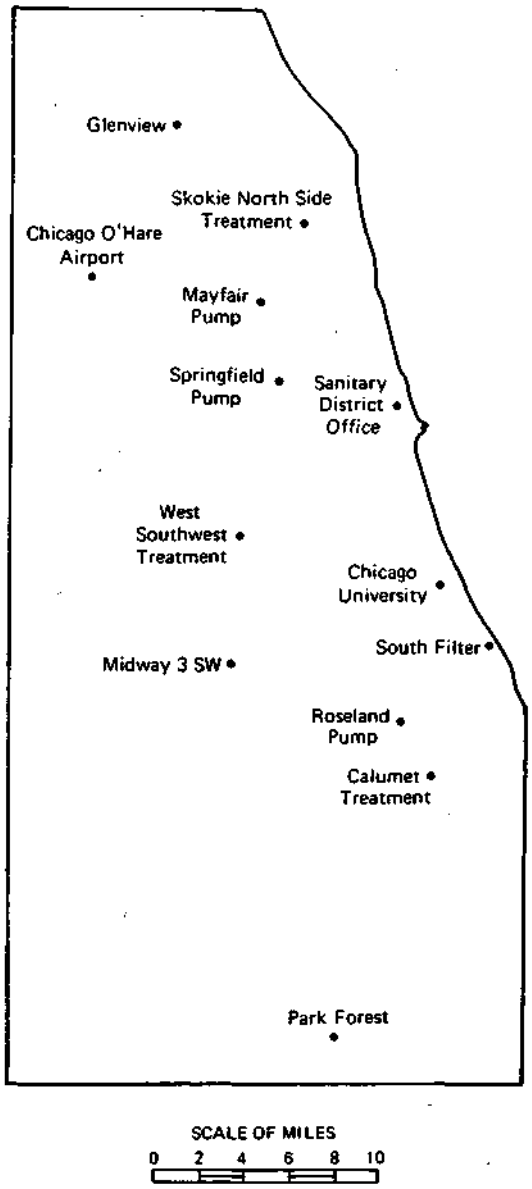

Figure 2. Raingage locations used for accounting procedure in Chicago area

missing for more than one storm was the West Southwest Treatment Works. This raingage was inoperative from 1100 on 21 October 1984 through 1800 on 3 March 1985.

In addition, hourly precipitation data from the Jardine Water Filtration Plant (City of Chicago) and daily precipitation amounts from other NWS stations (Table 1) in Northeast Illinois were used to generate spatial storm patterns. The data from the NWS stations were taken from the NCDC's Climatological Data. Illinois (1984 and 1985). All the stations used in this analysis are shown in Figure 3.

EVALUATION OF PRECIPITATION FOR WATER YEAR 1985

Hourly precipitation data for each of the recording raingages used in the accounting procedure were printed chronologically in columns by hours and days, providing a matrix of all hourly precipitation data with all stations printed side by side. This matrix was used to check the data for possible time inconsistencies, and to divide the precipitation data into storms. For this study, a storm was defined as a rain period separated from preceding and succeeding precipitation by 6 hours or more. This definition was used successfully by Huff (1967) for a similar sized area in Central Illinois; by Vogel (1986) to define extreme storm events in the Chicago area; and by Vogel (1988) to define storms for the 1984 Water Year.

Overall, 155 individual storms were defined and plotted using the hourly precipitation data from the raingages in the Chicago area, and daily precipitation amounts from other NWS raingages in the Chicago area and Northeast Illinois. The isohyetal pattern for each storm was determined by using all available precipitation data in the Chicago area and the surrounding counties. The NWS raingages were given more weight in defining

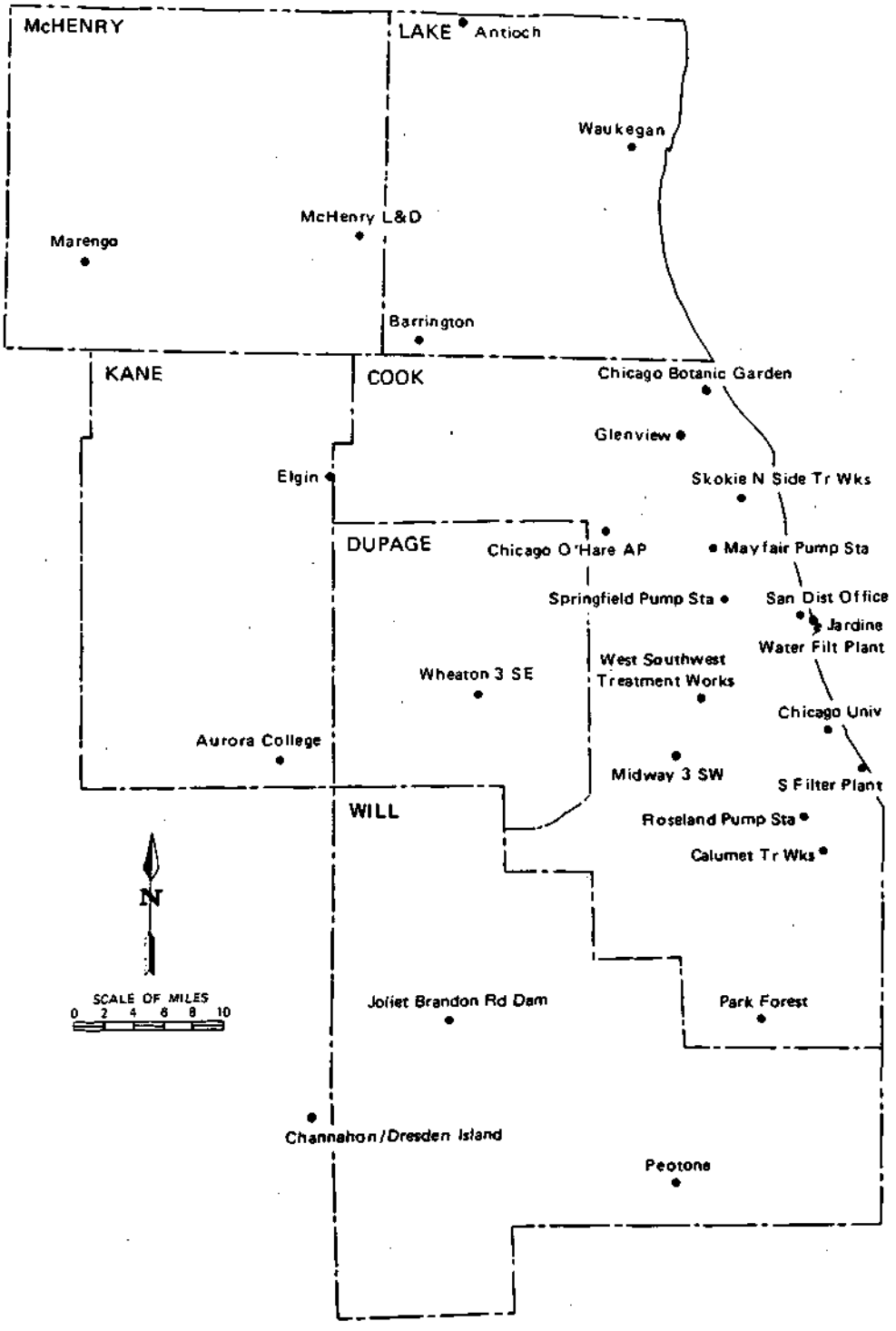

Figure 3. Raingage locations used in Northeast Illinois

the isohyetal pattern because many of the raingages maintained by the MSD and the City of Chicago have exposure problems (Vogel, 1988). After a generalized precipitation pattern was obtained for each storm, a corrected storm precipitation total was determined for those raingages used in the accounting procedure which were in error. This corrected total was estimated directly from the generalized storm isohyetal pattern. The corrected total was then distributed hourly using the hourly percentage of the uncorrected precipitation recorded at each gage.

The raingage at the West Southwest Treatment Works was inoperative from 1100 on 21 October 1984 through 1800 on 3 March 1985. As a result, precipitation amounts were estimated for all storms at the West Southwest Treatment Works during this period.

The accumulated storm corrections (Figure 4) for the 1985 Water Year was largest at Calumet (17.47 inches) in the southern part of the Chicago area. The second highest accumulated correction was at Glenview (11.07 inches) in the northern part of the network. These two stations also had the highest and second highest corrections during the 1984 Water Year. Roseland Pump Station, approximately 2.5 miles north northwest of Calumet, had an accumulated storm correction of 8.58 inches. The remaining corrections ranged from 2.46 inches to 8.23 inches (Table 2). The total correction for the West Southwest Treatment Works was 17.13 inches. However, 13.19 inches of this correction was due to data that were missing from 21 October 1984 to 3 March 1985. An estimate of the correction for that period was made by multiplying the estimated data for that period by 20.1%, or the percent error when data were available. Thus for the missing

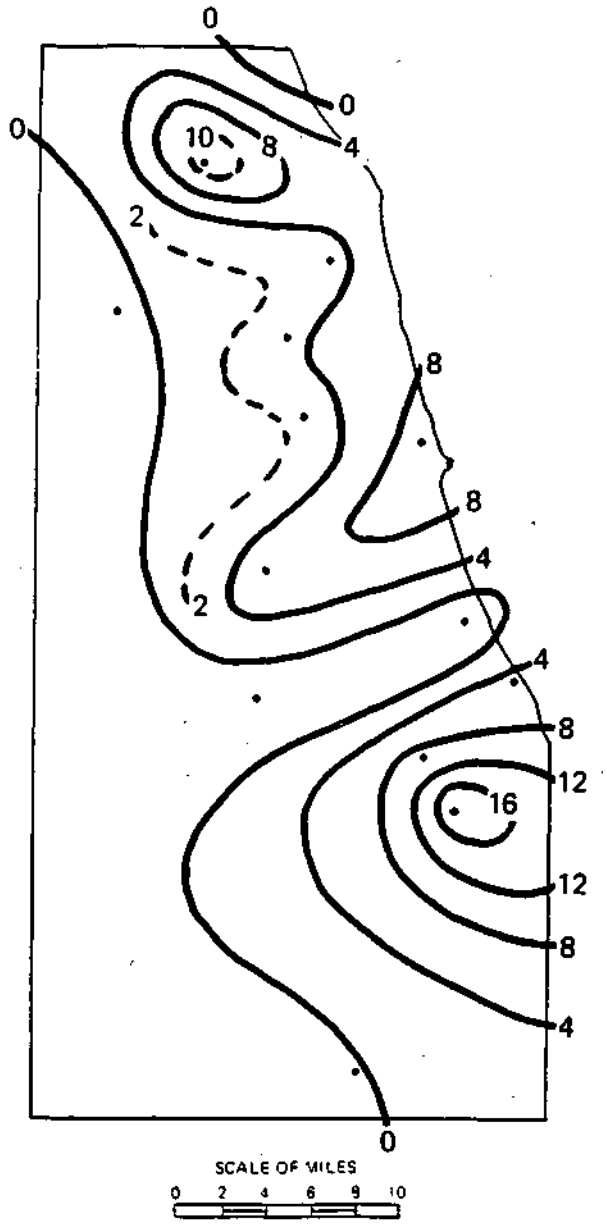

Figure 4. Accumulated storm corrections (inches) for 1985 Water Year

period, the correction was estimated to be 2.45 inches. This was added to the correction of 3.94 inches to obtain an estimated total correction of 6.39 inches. This total estimated error and percent error for the West Southwest Treatment Plant are consistent with the errors found for the 1984 Water Year (Vogel, 1988). No corrections were needed at the four recording raingages maintained by the NWS (O'Hare International Airport, Midway 3 SW, Park Forest, and University of Chicago). Figure 5 gives the percent change from the original 1985 Water Year precipitation values. The greatest percent changes were 83.2% at Calumet and 46.2% at Glenview. The only other changes greater than 20% were 27.9% at Roseland Pump Station and 29.5% at the Sanitary District Office. These percent errors are consistent with those found for the 1984 Water Year. The percent change in precipitation for the stations in the Chicago area are also presented in Table 2.

The final 1985 Water Year revised precipitation amounts are displayed in Figure 6a. A general maximum was observed over the south in the vicinity of Midway 3 SW, the South Filter Plant, and Roseland. A general decrease in precipitation was observed to the north, except for a local maximum near the Chicago Botanic Garden. A general minimum extends northwest from near the Sanitary District Office toward Glenview and O'Hare International Airport. The overall 1985 Water Year precipitation pattern for Northeast Illinois is given in Fig. 6b. Overall, the revised Chicago precipitation pattern fits well with the general precipitation pattern for Northeast Illinois.

Table 2. Accumulated Correction and Total Percent Change During 1985 Water Year for Raingages Used in Accounting Procedure

Station	Accumulated Correction	Percent Change
Calumet Treatment Plant	17.47	83.2
Chicago O'Hare Airport	0.00	0.0
Glenview	11.07	46.2
Mayfair Pump Station	3.93	12.6
Midway 3 SW	0.00	0.0
Park Forest	0.00	0.0
Roseland Pump Station	8.58	27.9
Sanitary District Office	8.23	29.5
Skokie Northside Treatment Works	3.98	13.0
South Filter Plant	4.29	12.1
Springfield Pump Station	2.46	7.2
University of Chicago	0.00	0.0
West Southwest Treatment Plant	6.39*	20.1*

* Estimated correction--Precipitation data missing from 20 October 1984 to 3 March 1985.

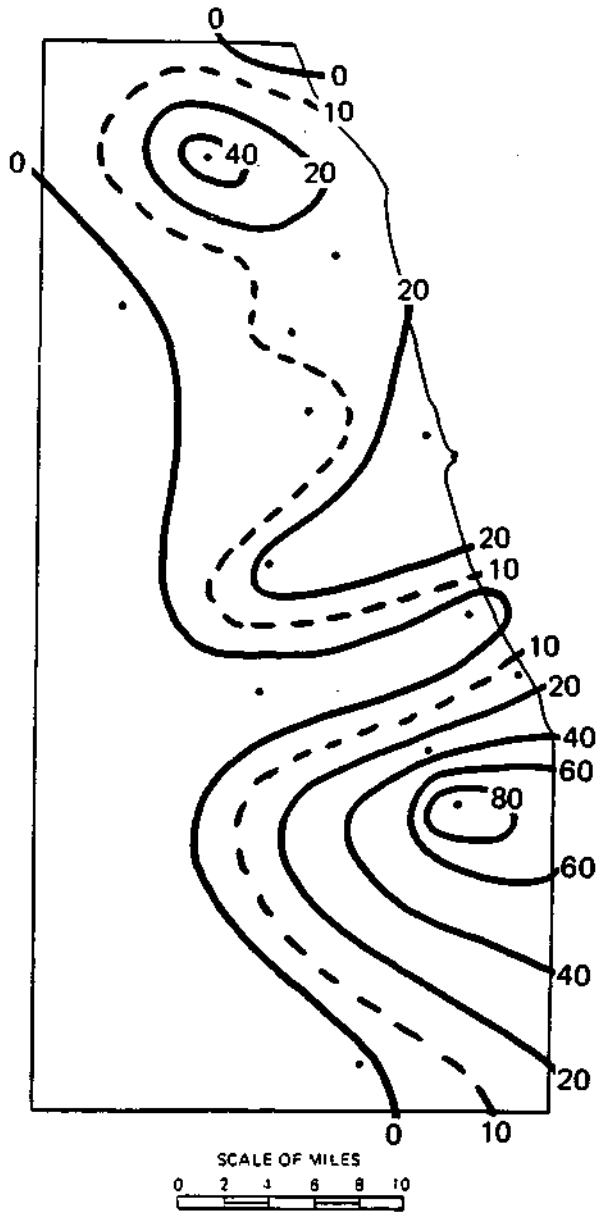

Figure 5. Percent change of precipitation from original 1985 Water Year

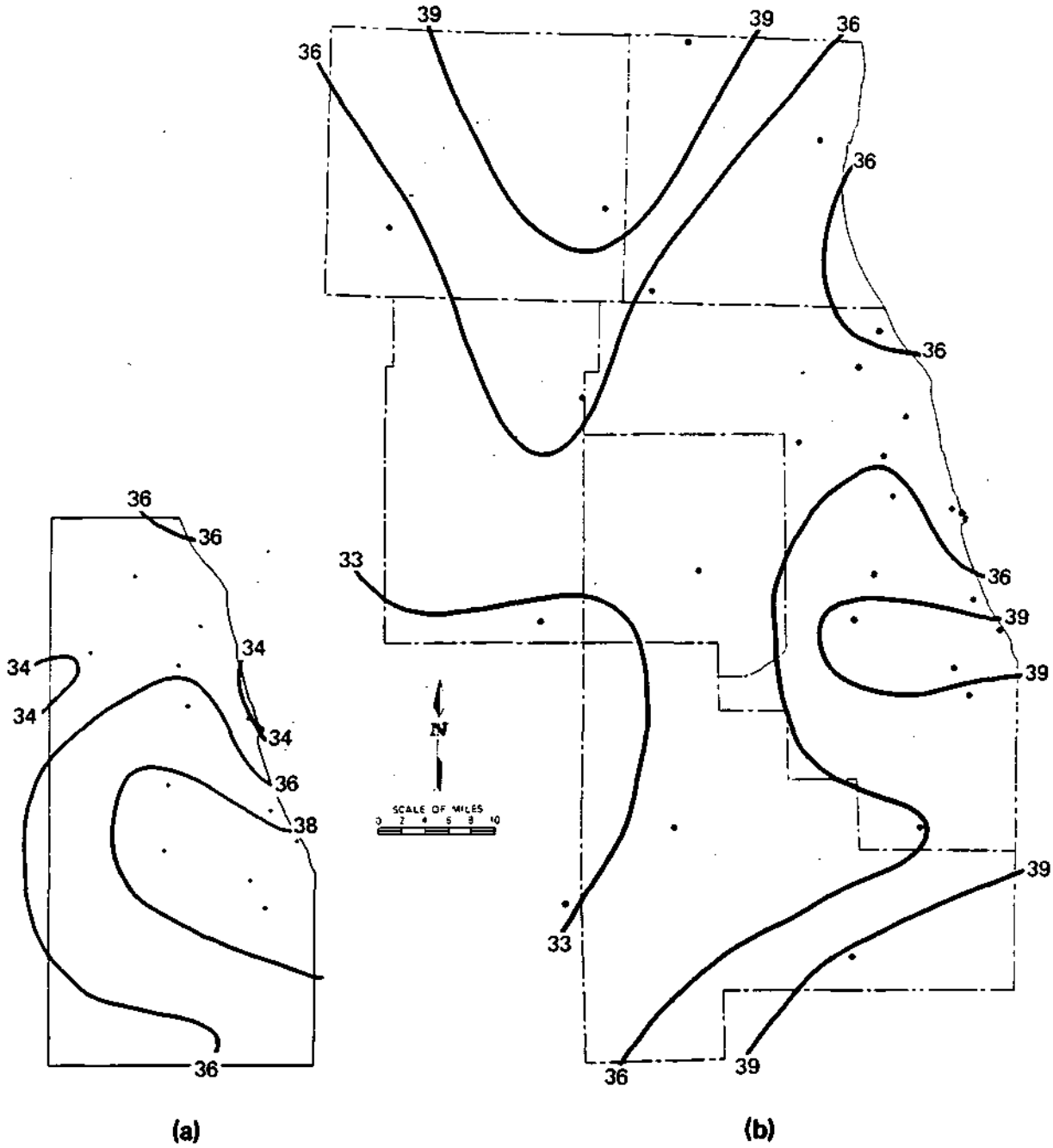

Figure 6. a) Revised 1985 Water Year precipitation (inches),
b) Overall precipitation pattern for Northeast Illinois

SUMMARY

Raingages used for the water accounting procedure by the Illinois Department of Transportation were analyzed for the 1985 Water Year. As in the 1984 Water Year some of the gages underestimated the annual precipitation totals. Using a procedure developed for the 1984 Water Year precipitation (Vogel, 1988), corrections were made. The greatest difference between the original reported precipitation and the final adjusted precipitation was at Calumet with a difference of 17.47 inches. The next biggest difference occurred at Glenview with a difference between the original reported precipitation and the adjusted precipitation of 11.07 inches. No corrections were made at the four recording raingages maintained by the NWS, and the remaining corrections over the Chicago area had similar percentage changes to the 1984 Water Year corrections. Estimates from October 20, 1984 to March 3, 1985 had to be made at the West Southwest Treatment Plant because of an inoperative gage. The corrected data with estimates of the hourly distribution of precipitation were sent to the Northeast Illinois Planning Commission.

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